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Abstract: Fieldwork during June 1999 on the northwest corner of Graham Island, British Columbia involved locating, sampling, and assessing previously studied high-stand deposits to gain insights into environmental and sea-level change. Shell material was obtained from three separate high-stand localities. Dating of these samples will provide a more complete record of high-stand elevations across the Queen Charlotte Islands thereby providing a more comprehensive data set with which to model isostatic sea-level response between 15 000 and 8500 ^{14}C years BP on the British Columbia continental margin. Significant evidence was obtained from intertidal shell material at the Haines Creek site to suggest abundant edible molluscs at this location at approximately 8500 ^{14}C years BP during sea-level high stand. Assuming this site fits into Queen Charlotte Island high-stand deposits, it can be inferred that edible molluscan biomass was available for a migrating people at this time.

Résumé : En juin 1999, des travaux sur le terrain menés dans la partie nord-ouest de l'île Graham (Colombie-Britannique) ont permis, entre d'autres, de localiser, d'échantillonner et d'évaluer des dépôts de haut niveau marin précédemment étudiés dans le but de comprendre les changements survenus dans l'environnement et le niveau de la mer. Des matériaux coquilliers provenant des dépôts de haut niveau marin ont été récoltés dans trois sites distincts. La datation au radiocarbone de ces échantillons fournira un relevé plus complet des altitudes de la limite de haut niveau marin dans les îles de la Reine-Charlotte et nous donnera ainsi un ensemble de données plus exhaustif pour la modélisation de la réponse isostatique du niveau de la mer le long de la marge continentale de la Colombie-Britannique entre 15 000 et 8 500 ans. Des données importantes tirées des matériaux coquilliers de milieu intertidal au site du ruisseau Haines nous amènent à penser qu'une abondance de mollusques comestibles existait à cet endroit durant la période de haut niveau marin il y a environ 8 500 ans. En supposant que ce lieu d'échantillonnage s'intègre bien aux autres sites des îles de la Reine-Charlotte qui renferment des dépôts de haut niveau marin, on peut croire qu'à cette époque une biomasse de mollusques comestibles était disponible pour l'alimentation d'une population en migration.

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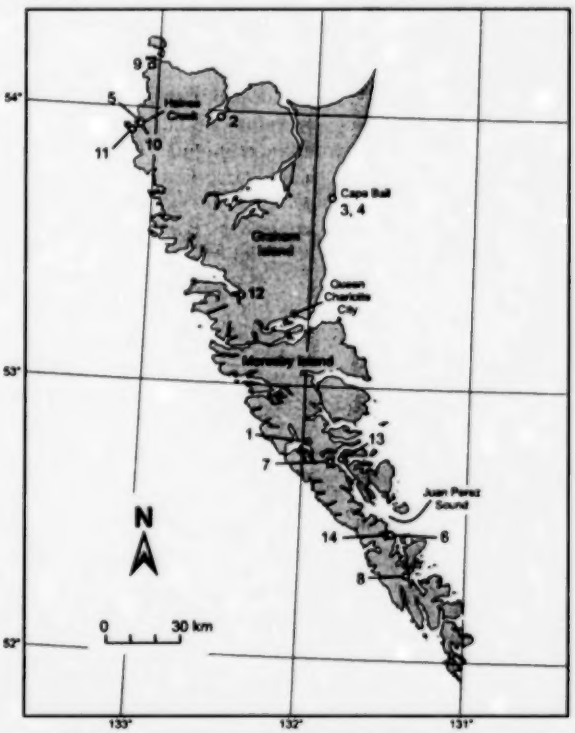
INTRODUCTION

Recent geological and archaeological research (White et al., 1985; Dillehay and Collins, 1988; Dillehay, 1989; Dyke, 1996; Jackson et al., 1997) suggests that the traditional migration route of an early people, east of the Rocky Mountains via a purported 'ice-free' corridor between 12 000 to 20 000 years BP, is not viable due to coalescence of the Laurentian and Cordilleran ice sheets. Researchers are now focusing on the possibility of alternate migration and/or colonization routes, particularly a coastal route, down the coast of Alaska and the Queen Charlotte Islands (Fladmark, 1979; Josenhans et al., 1995; Heaton et al., 1996; Barrie and Conway, 1999).

This research focuses on the possibility of a coastal migration and/or colonization route via the Queen Charlotte Islands during the period 15 000–8500 years BP. It assesses two aspects of the changing environment in the Queen Charlotte Islands during this period, sea-level change, and available edible biomass for early human populations. These two scientific themes are related in that sea-level change influences overall landmass, coastline topography, paleoshorelines, and potential glacial refugia. In so doing, sea level not only influenced potential migration routes and archaeological site locations, it also influenced the habitats and availability of food resources on which early humans depended. Potential food resources of an early coastal migrating population would likely include intertidal edible molluscs, an accessible, highly nutritious food source, available during the winter. Estimations of edible intertidal molluscan biomass are required to indicate whether surviving molluscan species reproduced in densities sufficiently high to be available as a subsistence resource for early peoples.

Subsequent to glacial maximum, between 21 000 and 15 000 ^{14}C years BP (Blaise et al., 1990; Barrie and Conway, 1999), the Queen Charlotte Islands experienced a significant regional fall of relative sea level of up to 153 m, as a result of rapid isostatic response to ice retreat, reaching the lowest level sometime before 12 400 ^{14}C years BP (Josenhans et al., 1997; Barrie and Conway, 1999). Ice retreat was rapid; deglaciation from Hecate Strait and Queen Charlotte Sound is thought to have occurred between 14 160 and 12 910 ^{14}C years BP (Luternauer et al., 1989b; Barrie et al., 1991; Barrie and Conway, 1999). Ice retreat resulted in subaerial exposure of large areas on the continental shelf east of the Queen Charlotte Islands (Josenhans et al., 1997). During transgression, subsequent to 9100 years BP, sea level rose at least 15 m above current levels (Clague et al., 1982; Clague, 1983; Josenhans et al., 1995). However, these sea-level fluctuations were local in nature (Clague et al., 1982; Clague, 1983; Josenhans et al., 1995). Significant variance in relative sea level has been found from west to east in response to ice loading and resultant isostatic crustal depression and rebound (Clague, 1983; Barrie and Conway, 1999).

An understanding of sea-level change at approximately 9000 years BP can be gathered from high-stand locations throughout the Queen Charlotte Islands. Dating of shell material found in high stands is one means of developing locally specific sea levels during the early Holocene, when sea level was above current mean sea level (m.s.l.). Dated high-stand facies and their respective elevations are used to indicate local isostatic response to ice loading and melting. These data are applied to an earlier period, when sea level was below present, to generate local relative sea-level curves, and to produce digital maps showing available landmass, coastal topography, and paleoshoreline, at intervals between 9000 and 14 000 years BP. These maps reveal potential migration routes as well as intertidal molluscan habitat locations and extent.



Reference #	Sample site	^{14}C yr BP	Lab #	Dated material	Elevation	Location
1	1	7460 ± 140	GSC 292	Shell	6	Tasu Sound
1	2	8480 ± 80	GSC 2443	Wood	ca. 12	Lignite Creek
1	3	8010 ± 80	GSC 2738	Shell	7	Cape Ball
1	4	8020 ± 150	GSC 242	Shell	7	Cape Ball
1	5	8180 ± 90	GSC 2635	Shell	ca. 6	Haines Creek
1	5	8250 ± 90	GSC 2534	Shell	ca. 2	Haines Creek
2	6	*	*	Shell	ca. 7	Upper Arrow Creek
2	7	*	*	Shell	ca. 3	Lockeport Estuary
2	8	*	*	Shell	ca. 3	George Bay
2	9	*	*	Shell	7.5	Lepas Bay
2	10	*	*	Shell	10.9	Haines Creek
2	11	*	*	Shell	18.1	Kennecott Point
3	12	*	*	Shell	ca. 15	Rennel Sound
2	13	*	*	Shell	ca. 1	Richardson Island
0	14	8850 ± 70	xxx	Wood	11.5	Arrow Lake

Reference #
1 Clague et al. (1982)
2 Hetherington (1990a, b)
3 V.J. Barrie (pers. comm., 1999)
0 Josenhans et al. (1986)

* Dating in progress
xxx Lab # not available

Figure 1. *Locations and radiocarbon dates of high-stand deposits on Queen Charlotte Islands.*

Intertidal molluscan habitats alter with changing environmental conditions such as sea level, temperature, salinity, currents, and sediment type. The complexities of sea-level variation in the Queen Charlotte Islands influenced local environment conditions and paleoshorelines during the late Wisconsinan glacial period. These alterations in habitat may have affected the ability of local paleointertidal molluscan communities to survive and/or produce high levels of edible intertidal molluscan biomass. Samples from paleointertidal sites both at high-stand and submerged locations permit a measure of the survival of individual intertidal molluscan species and levels of edible intertidal molluscan biomass. Densities of edible mollusc shell provide indications of edible biomass available to early humans. Hetherington et al. (1998) and Hetherington (1999a, b) have observed the presence of intertidal molluscan communities in Juan Perez Sound (Fig. 1) which date from 9930 ±40 to 11 120 ±50 ^{14}C marine reservoir corrected years BP, at depths ranging from 55.7 m to 128 m below m.s.l. Six sampled locations contain substantial edible intertidal biomass and are located during possible still stands at depths of approximately 55 m, 120 m, and 130 m below m.s.l. Similar intertidal molluscan communities have also been observed in high-stand deposits in Lockeport Estuary, George Bay, and Upper Arrow Creek at elevations of about 1–7 m above m.s.l. (Fig. 1). Substantial edible intertidal biomass was also observed in these three high-stand deposits. The findings suggest intertidal molluscan communities survived and were able to produce large quantities of edible biomass during rapidly changing sea levels throughout the most recent sea-level transgression on the east coast of southern Moresby Island. The implications are that paleointertidal molluscan communities were able to survive and reproduce in relatively high densities during late glacial conditions, and keep pace with a rapidly transgressing shoreline following ice retreat. Paleointertidal molluscan community survival during late glacial conditions has not been determined for other localities on the Queen Charlotte Islands.

METHODS

Fieldwork during June 1999 focused on the northwest corner of Graham Island where three high-stand localities were sampled, Kennecott Point, Haines Creek, and Lepas Bay. Differential GPS was used to obtain accurate site location information. Five bulk samples of approximately 0.5 m^2 to 10 cm depths were obtained from the Kennecott Point locality. This method is consistent with modern biomass survey methods (Quayle and Bourne, 1972; Gillespie and Kronlund, 1998). A 65 cm by 1 m pit was dug; five 10 cm levels were removed to a depth of 50 cm. Six bulk samples averaging approximately 0.37 m^2 to 10 cm depths were obtained from the Haines Creek locality. Bulk samples were not obtained from the Lepas Bay site, although numerous samples were taken for ^{14}C dating purposes. Sediment samples weighing approximately 1 kg were collected from sampled facies at each locality. Bulk samples were sieved to collect shells at the Geological Survey of Canada's Pacific Geoscience Centre at Sidney, British Columbia using 1 mm and 2 mm screens. Samples were then sorted by species and weighed. Edible intertidal mollusc weights were multiplied by species specific biomass factors (Erlandson, 1984; R. Reid, pers. comm., 1999) to determine edible biomass levels represented. Intertidal mollusc specimens have been chosen for ^{14}C AMS dating from selected intervals at each of the high-stand deposits.

RESULTS

Figure 1 provides a summary of published raised beach or high-stand deposits on the Queen Charlotte Islands. Also shown are the available elevations and ^{14}C dates. Included are the three high-stand locations sampled during this fieldwork — Kennecott Point, Haines Creek, and Lepas Bay.

The Kennecott Point high stand is located at an elevation of 10.9 m in the rainforest approximately 300 m east of the present beach (Fig. 1). Five, 10 cm thick samples were removed. The top 10 cm sample consists of modern humus soil with high wood concentrations. The next 10 cm sample consists of humus and fine sand. The third 10 cm sample is fine-grained, light grey sand and gravel mixed with soil and angles sharply downwards to the west side of the section. The fourth 10 cm sample is organic-rich, brown gravel with pebbles to 25 mm. The bottom sample is a firmly packed, dark brown sandy soil.

The Haines Creek high-stand locality is located approximately 8 km northeast of Kennecott Point, at the confluence of a small creek into Haines Creek on the north side, about 4 km from the mouth of Haines Creek (Fig. 1). The site is

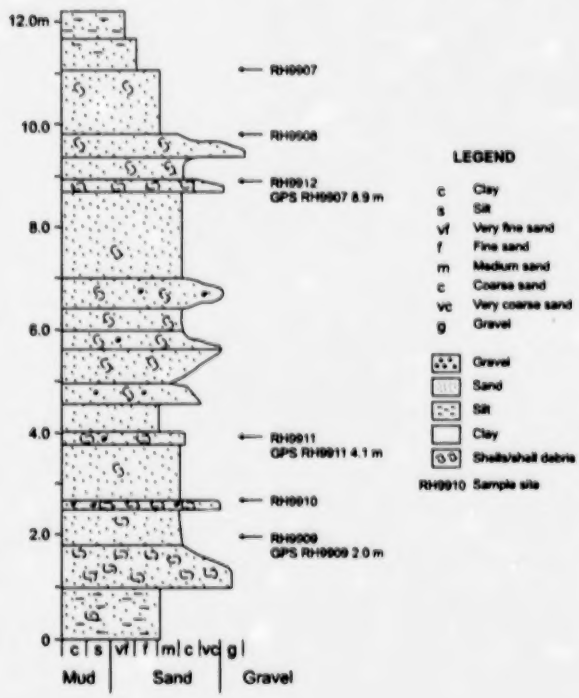


Figure 2. *Stratigraphy and lithology of Haines Creek site.*

approximately 12.0 m high and 60 m wide. Shell is eroding out of the site and is visible on the small beach in front of the site and in the creek water below the site. The stratigraphy and lithology of the Haines Creek site is outlined in Figure 2. It consists of seven units of gravel and/or coarse sand and shell interspersed with units of sand and shell, overlain by fine sand and sandy silt units. Coarser facies generally contain higher concentrations of shell. Some shells appear in growth position and are articulated. The facies sequence is interpreted to be an intertidal and supratidal high-energy beach deposit.

The Lepas Bay high stand is located approximately 25 km north of Kennecott Point. It lies 7.53 ± 1.79 m above m.s.l. The section consists of a sand and fragmented shell unit approximately 2 m thick, overlain by a coarse sand and gravel unit, which contains shell material. This second unit contains a few complete shells, with many small shell fragments. A thin unit of organic sediment, which is overlain by another coarse sand and gravel unit containing shell material overlies the second unit. The uppermost of these sand-gravel-shell layers was sampled for intertidal molluscs for ^{14}C AMS dating. Overlying all the units is a 10 cm organic unit.

DISCUSSION

Recent archaeological and geological research has led to a revision of the 'Traditional' peopling model of the Americas. A coastal migration route has been proposed by Fladmark (1979); Luternauer et al. (1989a); Josenhans et al. (1995) and others. However, little evidence has been collected to defend this thesis. Malacology is one tool used to provide greater insight into the environment of the late Pleistocene–early Holocene and to provide evidence for the presence of edible intertidal subsistence resources available to support a coastal migrating and/or colonizing population.

High-stand deposits range from 1–18.1 m a.s.l. on the Queen Charlotte Islands (Fig. 1). Elevation variations may be a consequence of preservation, or they may be a result of variations in local sea-level transgression elevations, or both. More dates are required to determine which is the cause. Time and high-stand elevation are not internally consistent, evidence that isostatic response was not everywhere uniform. It is not clear whether the dated high-stand facies are from transgressive or regressive sequences. Dating multiple levels of the Haines Creek deposit may assist in resolving this question. Once an understanding of relative isostatic response can be determined, a model of locally specific sea levels can be developed which will be useful for paleoshoreline reconstruction. Such a model will allow greater predictive capacity for paleointertidal locations, potential migration routes, and archaeological sites, throughout the period from 15 000–8500 ^{14}C years BP.

SUMMARY

Initial results suggest that the elevation of 18.1 m at the Kennecott Point high-stand site indicates that either sea-level transgression and resultant marine submergence was higher than 14 m (Josenhans et al., 1995) indicated for the Matheson Inlet region and the 15 m on western Graham Island (Clague et al., 1982), or that marine submergence varied throughout the Queen Charlotte Islands. This variance may be a local phenomenon, either isostatically or tectonically driven.

Comparative ^{14}C AMS dating of intertidal shell samples obtained during fieldwork in June 1999 will be used for an initial comparison with other Queen Charlotte Island high stands. These dates and their respective sample elevations will determine if differences exist between high-stand localities that generate locally specific sea-level curves.

Molluscan shell is present in one facies at Kennecott Point, in the one sampled facies at Lepas Bay, and in all sampled facies at the Haines Creek site. Evidence for edible molluscan biomass has been collected at Haines Creek. Samples RH9909 and RH9911 (Fig. 2) contain significant quantities of edible intertidal shell material, suggesting high levels of edible biomass when sea level was at the sampled facies elevation. These data indicate food resources would have been available to a coastal migrating and/or colonizing population during the time when sea levels reached sampled elevations.

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